

Our Ref: 08/322

The Infrastructure Coordinator
Infrastructure Australia
GPO Box 594
CANBERRA ACT 2601
AUSTRALIA

15 October 2008

RE: Response to Infrastructure Australia Discussion Paper #1 - "Australia's Future Infrastructure Requirements"

Dear Sir/Madam

Thank you for the opportunity to provide input to the questions raised in Infrastructure Australia's *Discussion Paper #1 Australia's Future Infrastructure Requirements*. Our comments are provided on the basis that CSIRO is actively undertaking research on issues of relevance to this review. In this regard, our contribution focuses on decision support, planning and policy analyses to support wise infrastructure choices

In addressing the issues raised in Discussion Paper #1, CSIRO has identified nine key suggestions that would add value to the Infrastructure Australia decision process:

- The development and application of integrated decision models that can handle sustainability objectives in the appraisal of infrastructure projects;
- The development and application of models to predict the cumulative, citywide and region-wide spill-over impacts (benefits and costs) of infrastructure projects;
- The development of a capacity to assess the non-infrastructure options (e.g. demand mitigation, congestion charges, city design, changed land use *etc*);
- Considering a special strategy to identify, and plan for, the infrastructure needs of indigenous, mining and other communities in remote Australia;
- The development of policies and standards for the modernisation of Australia's electricity grid to meet growing demand for climate related responses such as the efficient and safe integration of renewable energy sources and distributed generation together with examination of options for distributed water systems;
- Supporting the development and adoption of nationally consistent planning guidelines for assessing climate change impacts for major infrastructure projects;
- Developing and implementing systems for monitoring the condition of existing infrastructure to ensure its safety and that maintenance operations are cost-effectively targeted to where they are most needed and possibly extending the life of existing infrastructure;
- Considering human health in infrastructure planning; and
- Considering the aesthetic benefits (and impacts) of infrastructure projects

Should you require any further information regarding our submission, please do not hesitate to contact me.

Yours sincerely

Peter King
Senior Adviser,
CSIRO Government and International



CSIRO Submission 08/322

Response to Infrastructure Australia Discussion
Paper #1 - "Australia's Future Infrastructure
Requirements"

October 2008

Enquiries should be addressed to:

Mr Peter King
Senior Adviser
CSIRO Government & International
PO BOX 225
Dickson ACT 2602
Australia
Email: PeterG.King@csiro.au
Ph: (02) 6276 6361

Main Submission Author:

Dr Stefan Hajkowicz
CSIRO Sustainable Ecosystems
306 Carmody Rd
St Lucia QLD 4067
Australia
Email: Stefan.Hajkowicz@csiro.au
Phone: 07 3214 2327

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Summary

This submission, by CSIRO, responds to questions raised in Discussion Paper #1 (Australia's Future Infrastructure Requirements) provided by Infrastructure Australia (IA)¹. Our contribution focuses on decision support, planning and policy analyses to support wise infrastructure choices.

CSIRO supports the goals and strategic priorities stated by Infrastructure Australia (IA). CSIRO agrees with the notion that “infrastructure does not matter for it’s own sake” and that it matters because it helps achieve social, environmental and economic objectives. We believe this will be an important philosophy to carry forward in planning for, and appraising, infrastructure projects. A challenge will be handling the intangible social outcomes within formalised evaluation frameworks.

Based on our expertise in this area we suggest that the decision process undertaken by IA would have added value through:

1. The development and application of integrated decision models that can handle sustainability objectives in the appraisal of infrastructure projects.

Benefit cost analysis (BCA) is an important tool which needs to be applied more often and to a higher standard. But BCA alone will not be sufficient to handle all intangible (non-monetary) environmental and social outcomes. For example, the protection of human life through improved transport safety will be a major benefit – but can this be captured in dollar units in BCA? Other intangible outcomes include biodiversity, recreation, scenery, health *etc*. We suggest Infrastructure Australia diversify and improve the economics evaluation toolkit to handle sustainability concerns adequately.

2. The development and application of models to predict the cumulative, citywide and region-wide spill-over impacts (benefits and costs) of infrastructure projects.

Society's ability to explain the broader social and environmental ramifications of infrastructure is limited. Often projects are assessed on an individual basis and we have insufficient knowledge of how the whole city or region works to permit a systematic evaluation of the optimum package of projects.

3. The development of a capacity to assess the non-infrastructure options (e.g. demand mitigation, congestion charges, city design, changed land use *etc*).

Intelligent policies, land use planning and urban design can often fulfil objectives more efficiently than traditional hard infrastructure. Complex policy responses require sophisticated techniques to appraise these options.

4. Considering a special strategy to identify, and plan for, the infrastructure needs of indigenous, mining and other communities in remote Australia.

¹ Whilst CSIRO research has some relevance to public private partnerships (PPPs), covered in discussion paper #2, it is not a focus of this submission.

5. The development of policies and standards for the modernisation of Australia's electricity grid to meet growing demand for climate related responses such as the efficient and safe integration of renewable energy sources and distributed generation together with examination of options for distributed water systems.

6. Supporting the development and adoption of nationally consistent planning guidelines for assessing climate change impacts for major infrastructure projects.

7. Developing and implementing systems for monitoring the condition of existing infrastructure to ensure its safety and that maintenance operations are cost-effectively targeted to where they are most needed and possibly extending the life of existing infrastructure.

8. Considering human health in infrastructure planning.

Australians are becoming too sedentary and this is partly the cause of health problems (such as obesity). We recommend that future cities encourage cycling and walking as means of transport and encourage outdoor physical recreation for young and old alike.

9. Considering the aesthetic benefits (and impacts) of infrastructure projects.

Although hard to quantify the benefits of artistic or aesthetically pleasing projects they can deliver large benefit; often at low cost. We argue that we have an opportunity to colour the nation's modern cultural identity through infrastructure projects which will be on display to the nation's people and our many visitors.

Question 1 - What is Infrastructure?

The discussion paper identifies three types of infrastructure: physical; digital and collaborative. CSIRO agrees this is a comprehensive definition of infrastructure and that Infrastructure Australia has taken the correct approach by focusing effort on physical and digital infrastructure. Whilst collaborative infrastructure is important it is being addressed through numerous other policy platforms.

Question 2 - Why is it Important?

Clearly infrastructure is important (crucial) to Australia's society and economy. Perhaps the question should be: To what extent is increased public, and private, sector investment in infrastructure warranted?

Whether we are under-investing or over-investing in infrastructure as nation is a complex question. Many are arguing that we have under-invested and much larger expenditure will deliver net benefits. For example, the Business Council of Australia (BCA, 2008) estimates Australia's GDP would be boosted by \$20 billion per annum (around 2%) via a series of major infrastructure improvements.

There is evidence of current infrastructure inadequacies through bottlenecks experienced in extractive industries, worsening traffic problems and the lack of internet access in remote Australia. However, CSIRO is not convinced the evidence base is strong enough to prove under-investment in all regions and community/economic sectors. It may be that in some cases we have over-relied on infrastructure options when other policy mechanisms might work better. It might also be that we have not always chosen the best infrastructure projects in the best locations. Therefore, we suggest it is important to continue to quantify the benefits and costs of infrastructure projects and compare them against the alternatives. This will be challenging because infrastructure delivers benefits over long time frames and has environmental, social and economic outcomes that are difficult to quantify in dollar units.

CSIRO supports the view that infrastructure “does not matter for its own sake” and that it serves to help Australia meet social, environmental and economic objectives. The goals and strategic priorities given in discussion paper #1 are all sound. The challenge will be determining the extent to which specific developments contribute to these goals. We do note, however, that these objectives will often need to be traded-off against each other. Some infrastructure developments can be harmful to greenhouse emissions or create social equity dilemmas whilst yielding other benefits.

CSIRO is working on a range of economic evaluation methods, decision tools and consultation processes which ensure the rigour of benefit cost analysis (BCA) but handle the triple bottom line in decision making processes. For more information please see www.csiro.au/science/SRD.html; and www.csiro.au/science/NRMInvestmentAnalysis.html.

In addition, CSIRO is developing an analytical capability and decision tools to help inform the investment in infrastructure decision making process, such that the choices made are done so in a robust, transparent and impartial manner.

Question 3 - What are the Problems?

CSIRO notes there are many pressing needs for new infrastructure to meet the objectives of Australian industry and society. Others with detailed industry or community knowledge will no doubt identify specific infrastructure requirements in locations throughout Australia.

In this submission we focus on challenges relating to the appraisal, planning and policy designs for new developments. We believe there are some challenges in planning for the nation’s infrastructure, which if overcome, could lead to better decisions. It is CSIRO’s contention that by utilising models that go beyond just a financial cost benefit analysis approach, the projects selected for support will be in the nation’s best interest. We also acknowledge the risks associated with delayed decision procedures and too much red tape. Intelligent decision systems and integrated models can give Australians a much better long-term return on investment.

We have observed several major planning challenges facing Australia’s infrastructure developments. These challenges, along with potential solutions are set out in the response to Question 5 below.

Question 4 - How did these Problems Come About?

Whilst Australia has made enormous investments in improved engineering and construction technology there has been limited investment in research into how we make decisions, design policies and engage communities. CSIRO believes the analytical capabilities of the nation need to be bolstered in these regards.

Question 5 - How Might these Problems be Addressed?

CSIRO generally supports what IA is proposing in this section. However, we would like to make an important addition. Creative and effective solutions to infrastructure problems are not likely to emerge without a deeper understanding of how cities and regions function. This includes all relevant social, environmental and economic aspects.

Solutions to the water supply crisis in South East Queensland, for example, depend on knowledge of all relevant supply augmentation and demand mitigation options. They require knowledge of the lifestyles of people living in the region and the unique natural landscapes that create water supply opportunities and constraints. This requires a knowledge of industry needs for water and the institutional structures to manage water. It also requires an understanding of risks through climate change.

CSIRO would like to stress is that this cannot be achieved without longer term, and deeper, research into how our cities and regions function. When the crisis hits and decisions are needed immediately it is too late to do this research. We would like to be prepared for the next infrastructure crises with solutions ready to go when economic, environmental and/or political conditions dictate. Wise infrastructure decisions will stem from a solid understanding of city/regional economies, societies and natural environments.

CSIRO suggests that problems might be addressed as follows:

1. The development and application of integrated decision models that can handle sustainability objectives in the appraisal of infrastructure projects.

CSIRO suggests development of improved methods to appraise infrastructure against sustainability criteria

Treasuries of all State and Territory Governments of Australia, and the Federal Government, have requirements for the application of benefit cost analysis (and related appraisal mechanisms) for new infrastructure projects. This is important and we believe there are ways to improve the application of benefit cost analysis (BCA) in infrastructure appraisal – in particular the handling of intangible social and environmental outcomes that are hard to quantify in dollar units. This is a major area of research for *CSIRO Sustainable Ecosystems* (Hajkowicz, 2007; Hajkowicz, 2008, Spash, 2006; Straton, 2006; Whitten and Bennett, 2002).

But we believe that sole reliance on BCA will be insufficient to guide our infrastructure investments. We would argue for the development and application of economic evaluation methods which preserve the analytic rigour of BCA but handle intangible environmental and

social outcomes that cannot easily be quantified in dollar units. This includes techniques of cost-effectiveness analysis (CEA), cost utility analysis (CUA) and multiple criteria analysis (MCA).

This is a major field of research for CSIRO (Higgins et al., 2008b; Hajkovicz and Collins, 2007). Our scientific and economic teams are applying techniques of CEA, CUA and MCA to a wide variety of environmental and social investment problems. The aim is to develop improved tools and decision procedures that help policy makers make informed choices.

We have reviewed IA's prioritisation methodology (published on 24 September 2008) and understand a process of "matrix mapping" will be used to visualise the assessment of infrastructure priorities. We understand this process is being developed and would be happy to discuss some of our established multiple criteria decision analysis models with IA (Marinoni et al., 2008). This supports interactive ranking/scoring of investment options in light of multiple (financial and non-financial) policy objectives. It is very encouraging that IA are aiming to include sustainability concerns into the prioritisation process but it is CSIRO's view the methods for how it would be handled alongside BCA were unclear and need to be refined. We would encourage the use (and improvement) of formal evaluation methods where possible as opposed to "rules of thumb". We would also support full transparency of the decision models via their open (and accessible) provision to the public.

Whilst BCA is supported by decades (a century) of theoretical development our knowledge of CUA and MCA (and to a lesser extent CEA) is not so well advanced. But they have much promise for operationalising the objectives of sustainability in public, and private, sector decision making. They are already being used to inform large investment decisions in Australia, Europe and the US. It will therefore, be important to develop, refine and apply these methods to support the complex choices and trade-offs faced by Australia's infrastructure planners. Given its importance and relevance this will continue to be an important research area for CSIRO.

2. Development and application of models to predict the cumulative, citywide and region-wide spill-over impacts (benefits and costs) of infrastructure projects.
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Capacity to predict the cumulative, systematic, city-wide and regional impacts of infrastructure projects is required.

One of the planning problems that CSIRO would like to highlight is the difficulty of understanding the system-wide impacts of major infrastructure developments. These may be felt at the city or regional level. We argue that a major road, bridge, tunnel or dam cannot be evaluated in isolation. Major developments will usually have significant spill over effects into the economy and how people live their lives.

This is partly evidenced by the large body of research on cumulative impact assessment (CIA) or cumulative effects assessment (Lawrence, 2007). CIA looks at the secondary spill over impacts, both positive and negative, of numerous individual projects. These impacts might not be evident on a case-by-case basis but when a large portfolio of infrastructure projects is viewed collectively they become very significant.

In order to judge the worthiness of infrastructure investments it is important to understand (and predict) the regional economic, environmental and social implications. A more complete evaluation can sometimes show that different configurations of the city-wide transport system or water supply system can more effectively achieve social goals (Bai, 2008). It is also important that we understand risks and CSIRO is working on advanced risk analysis methods to inform water planning decisions (Higgins et al., 2008a).

Sometimes demand mitigation, especially in the case of water and energy, can be much more cost-effective than building new infrastructure.

CSIRO is moving towards more integrated and systematic models to evaluate specific infrastructure proposals in the context of the entire urban or regional system. For example, Integrated Urban Water Management (IUWM) is an emerging approach for planning and management of urban water systems to plan and manage water supply, wastewater and stormwater systems in a coordinated manner to:

- minimise their impact on the natural environment
- maximise their contribution to economic vitality
- engender overall community wellbeing and improvement.

The research is aimed at providing method, and where applicable modelling tools, for quantifying system-wide:

- water quality
- energy
- greenhouse gas emissions
- social and economic implications (for details on CSIRO's socio-economic research see <http://www.csiro.au/science/SocialEconomicSciences.html>).

This is to feed into triple bottom line (TBL) decision-making frameworks for evaluation of IUWM interventions under changing climate and resource use pressures. The outcomes of the research provide underpinning science required to aid adaptive management of water supply, wastewater and stormwater strategic planning.

This is one of many examples of system wide models that CSIRO is developing which could be used to examine the broader social and economic consequences of infrastructure development.

3. The development of a capacity to assess the non-infrastructure options (e.g. demand mitigation, congestion charges, city design, changed land use *etc*).

There is value in “wind-tunnel testing”, and designing policy mechanisms to ensure successful delivery of infrastructure projects

How would Brisbane drivers respond to a congestion charge? How much should it be? Will drivers be willing to pay a tunnel toll? Or is toll-fatigue such that they'd prefer a longer trip on surface roads? Will people ride to work more if a new bikeway is constructed?

The answers to questions of this nature are not obvious and crucial in determining the success or failure of new infrastructure projects. Knowing how markets will respond, and subsequently how we can best design them, is at the forefront in thinking for many CSIRO researchers in the fields of economics and human behaviour. Through experimental economics we are gaining insights into how best to design new water and environmental markets (Reeson and Tisdell, 2008).

CSIRO concludes that infrastructure Australia would benefit from exploiting an analytic capability to predict how people, and markets, will respond to new infrastructure projects. This will help the nation choose better options.

4. Considering a special strategy to identify, and plan for, the infrastructure needs of indigenous, mining and other communities in remote Australia.

The special needs of remote and regional Australia in light of the ongoing mining boom call for improved understanding and planning

Very remote Australia covers 73% of the country, contains only 0.9% of the population, but contributes significantly to our GDP and exports (ABS, 2004). This creates some challenges for infrastructure provision. For example, in “remote” and “very remote” Australia around 48% and 58% of households have no internet connection. This compares to around 34% in major cities (ABS, 2006). The vast distances, low population densities and “fly in fly out” mining communities massively increase the per-capita costs of infrastructure provision. But this infrastructure may be crucial to ensure remote Australia, and its contribution to the economy, remain viable.

CSIRO suggests that a special strategy is developed to plan for the unique needs of remote and regional Australia. At this stage the infrastructure requirements for remote Australia are not well understood. This partly results from a lack of a well articulated and agreed vision for the future of Australia’s remote communities.

The CSIRO Sustainable Regional Development (SRD) theme is conducting research into policy solutions for remote and regional Australia. We are working to understand the needs of remote indigenous communities. It is through this research that we hope to help chart a path for the sustainable development of Australia’s outback.

5. The development of policies and standards for the modernisation of Australia's electricity grid to meet growing demand for climate related responses such as the efficient and safe integration of renewable energy sources and distributed generation together with examination of options for distributed water systems.

The environmental and economic benefits of distributed energy (DE) infrastructure could be exploited.

Considerable investment in energy infrastructure has occurred in recent years to cater for continued growth in peak demand. Small scale local generation and demand management technologies provide a mechanism to minimise this investment (and hence the cost to society) through reduction in demand and more efficient generation. While adoption of these technologies provides many advantages for society and the environment, existing regulation encourages a perpetuation of current large scale centralised technologies to meet demand. CSIRO acknowledges that initiatives of the Ministerial Council on Energy (MCE) are currently underway with the aim of creating a fairer, more equitable and efficient market. CSIRO supports the continuation of these mechanisms aimed at harmonisation of policy and regulation across all

states. It also encourages the continual investigation of methods to allow robust and efficient markets to provide logical solutions to the country's infrastructure needs. CSIRO believes however that a system wide approach evaluating the economic, environmental and social issues is necessary to ensure the market responds appropriately to society's needs.

In particular, Australia's ageing electricity distribution network will not meet the growing and increasingly complex needs of industry or consumers in the future. Today, Australia's electricity grid touches every part of this country and every part of the economy whether services, manufacturing or tourism. The grid is based on a very old and traditional model of centralised generation with its associated distribution networks, that incurs significant losses and offers little flexibility or resilience to tackle climate change challenges. The electricity network requires modernisation and would benefit from extension across transmission and distribution networks to the consumer and industrial user.

Whilst MCE has recently endorsed a program for the roll out of smart meters, CSIRO considers that this will not in itself deliver the paradigm and capability shift necessary to deliver a level of distributed intelligence to support new climate initiatives such as the large scale deployment of renewable technologies. CSIRO supports the concept of an intelligent grid for Australia which it considers necessary to underpin the nation building program outlined by Government and to ensure industry, business and consumers are able to use electricity more effectively and ultimately reduce the peak nature of demand.

Today's grid is inherently inefficient with large assets in the generation chain idle other than meeting the increasing daily peaks. New initiatives such as real time demand response and energy efficiency are initiatives that could be employed to ultimately reduce peak demand and ensure greater utilisation of assets for such a capital intensive industry.

Utilities propose to spend tens of \$billions over the next five years and Australia must ensure that this significant investment delivers forward looking capabilities to create a smarter Australia.

CSIRO, in partnership with the electricity industry, can ensure Australia's electricity grid transitions to an intelligent platform that is secure, reliable and flexible to meet Australia's changing needs and ensures a climate smart sustainable solution.

It is worth noting that solutions to potential infrastructure issues do not necessarily lie with the construction of new infrastructure. Alternative solutions may exist through the adoption of different mechanisms. Recent CSIRO analysis of water related energy use in Australian cities indicates that a 15% reduction in the use of residential hot water through demand side measures or an equivalent increase in the energy efficiency of hot water systems (eg gas boosted solar systems) would completely offset the current total energy use of urban water utilities for water and wastewater service provision (Kenway et al., 2008). A widespread uptake of alternative energy scenarios could therefore potentially mitigate the significant expected increase in energy demand for manufacturing water through desalination or recycling and avoid the need for additional energy generation capacity.

CSIRO studies in a Victorian rural town have found that adoption of DE technologies by four major businesses could easily deliver an ambitious goal of a 30% reduction in greenhouse emissions by 2010. These savings are realised through a reduction in transmission and distribution losses and utilisation of more greenhouse friendly fuels and renewable technologies. Furthermore these changes can occur with pay back periods less than 3 years (Gardner et al., 2008).

CSIRO simulations of cogeneration in apartment complexes have shown the potential to save greenhouse emissions equivalent to taking 1 vehicle per occupant off Australia's roads, while maximising profits for a energy service provider and providing the space heating, hot water and electricity needs of each household (Weiskircher, 2008).

Australia wide, transmission and distribution losses are estimated at 8% of the total generation. This is equivalent to 18,000 gigawatt hours and is responsible for approximately 16 million tonnes of carbon dioxide emissions. Distributed energy located close to load and utilising modern efficient equipment can substantially reduce this wasted resource and delay or defer continual inefficient spending on upgrades to existing poles and wires, and manufacture of large scale generation facilities used for a small number of hours each year.

We also note that distributed water supply systems (e.g. rainwater tanks, stormwater harvesting) have the potential to reduce the risks and costs of centralised options (e.g. dams, desalination plants) in a similar way to energy systems. CSIRO is working with the University of Queensland, Griffith University and Queensland Government to explore options for decentralised water supply and stormwater harvesting in South East Queensland. Early results show that for the 2004/05 year in South East Queensland the rainfall on urban areas amounted to 1,309 gigalitres. This compared to 480 gigalitres from centralised or imported water supplies (Philp et al., 2008). This suggests there is huge potential to meet the region's water needs by more effectively capturing rainfall with decentralised infrastructure.

6. Supporting the development and adoption of nationally consistent planning guidelines for assessing climate change impacts for major infrastructure projects.

Climate change should be taken into account in planning for, and appraising, infrastructure projects

1, Mitigating Greenhouse Gas Emissions

It is estimated that the "services, construction and transport" sector of the Australian economy contributes some 59.5 million tonnes (10%) of carbon dioxide equivalent (Mt CO₂-e) of total emissions. The "electricity, gas and water" sectors contribute 204.5 Mt CO₂-e (36%) of the total (Australia's National Greenhouse Accounts, 2006). Emissions of greenhouse gases from both these sectors will be significantly influenced by the types of, and configurations of, infrastructure options. CSIRO suggests that IA consider ways to formally assess greenhouse gas emissions associated with major infrastructure projects. We would raise the question of whether future projects funded by the Commonwealth should aim to be carbon neutral? Techniques of life cycle

assessment (LCA) might helpfully address carbon emissions alongside other environmental impacts. For examples of this work please see: <http://www.csiro.au/science/WaterLCA.html>.

2. Ensuring infrastructure is protected from the damaging consequences of climate change

There is scientific evidence that climate change will result in higher sea levels, higher temperatures, changed rainfall patterns and extreme weather events. This will place existing and future infrastructure, which is concentrated in highly populated coastal regions, at risk. Already CSIRO has begun assessing the impacts in parts of the country and the CSIRO Climate Adaptation Flagship has a major project underway in South East Queensland. This may lead to changes in the way we conduct development assessment, building codes and where (and what types) of infrastructure we build. For more information on this work please see:

<http://www.csiro.au/org/ClimateAdaptationFlagshipOverview.html>.

3. Planning for water supply infrastructure in light of climate change

Australian cities and regions are already under water supply stress due to recent droughts. Climate change will possibly lead to lower rainfall in some parts of the country which will exacerbate this situation. CSIRO research predicts that decreases in annual average rainfall are likely in southern Australia - rainfall is likely to decrease in southern areas during winter, in southern and eastern areas during spring, and along the west coast during autumn. For 2030, there will be little annual rainfall change in the far north (CSIRO and the Australian Bureau of Meteorology, 2007).

Understanding how climate change will impact on our future water supply requirements will be crucial for effective infrastructure planning.

4. National Planning Guidelines and agreed standardised scenarios

All the above issues require a modest set of nationally agreed future climate scenarios against which best practice planning can be applied and defended. IA would benefit by developing, or supporting the development of, low, medium and high climate change scenarios with regional resolution of effects such as temperature, run-off projections, sea level rise and storm surge probabilities, which could be updated from time to time by CoAG agreement, and which would be associated with standard risk management methodologies for their use. CSIRO suggests that these guidelines would most logically be achieved through a National Planning Code that included reference to these scenarios, but obtaining timely national agreement on planning scenarios and guidelines should not be delayed to obtain agreement on a complete National Planning Code package.

<p>7. Developing and implementing systems for monitoring the condition of existing infrastructure to ensure its safety and that maintenance operations are cost-effectively targeted to where they are most needed and possibly extending the life of existing infrastructure.</p>
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Improved low cost surveillance systems could monitor the condition and safety of existing infrastructure and target maintenance.

In addition to building new infrastructure the nation has the enormous challenge of maintaining the safety and condition of existing infrastructure. For example, in October 2006 traffic engineers

in Brisbane found a small crack in the riverside expressway which led to the closure of the Ann and Alice Street on ramps, as well as a section of road from North Quay to Elizabeth Street (ABC News, 17 October 2006). This created severe traffic congestion and the Queensland Retail Traders and Shopkeepers Association estimated the road closures cost inner-city businesses between \$2 million and \$3 million per day in lost trade (ABC News, 21 October 2006). This was in addition to the time lost by commuters and transportation companies.

CSIRO is working on remote surveillance technologies and wireless sensor networks to help detect problems in infrastructure and ensure maintenance is targeted. For example, the NSW Roads and Traffic Authority (RTA) is responsible for monitoring and maintaining the condition of roads in NSW. The RTA came to CSIRO for the solution to the problem of gaining a vast improvement in the quantity and the quality of information on cracking in roads and highways. Our solution was the world's first real-time crack detection and classification system. A specially fitted truck, fitted with powerful lights and a high-speed digital camera, continuously captures images of the road (each 500 millimetres by 750 millimetres) as the vehicle travels at speeds up to 100 kilometres per hour.

The vehicle can survey over 500 km in a day; 20,000 km in NSW and 1,500 km in South Australia were surveyed during the first half of 1998. All cracking greater than 1 mm in width is detected. All processing is carried out in real time on board the vehicle, so the results of a day's survey are available as soon as the survey is finished. The benefit is better road management based on much more detailed information than was available previously.

More information on this project is available at

<http://www.cmis.csiro.au/IAP/recentprojects/roadcrack.htm>. Many other types of remote surveillance systems are possible such as the use of unmanned air craft to monitor electricity transmission lines and CSIRO would suggest that IA explore, and where appropriate, invest in these systems to ensure effective maintenance and safety and potentially extend the life of our existing infrastructure.

8. Considering human health in infrastructure planning.

Human health and aesthetic aspects should be taken into consideration for infrastructure options

In 2005, 7.4 million Australians aged 18 years and over (54% of the adult population) were classified as overweight or obese, an increase from 5.4 million adults (45% of the adult population) in 1995 (ABS, 2007). A key risk factor for obesity is physical inactivity.

There is evidence that city design (and infrastructure planning) impacts on human health. Research from the United States (Vandegrift and Yoked, 2004) shows that urban sprawl leads to physical inactivity and problems of obesity. Another study from Sweden (Lindstrom, 2008) finds that walking, cycling and taking public transport to work are significantly negatively correlated with obesity – *i.e.* people who get to work in these ways (as opposed to driving) are much healthier.

We suggest it stands to reason that cities which promote walking, cycling and outdoor recreation are likely to promote better health outcomes – both in terms of physical and mental well being. This should be considered in the construction of transport networks. For example, would it be possible to value the health benefits of a cycle-way and include them in a benefit cost analysis? We believe that effort should be made to include these hidden benefits of infrastructure projects in such analysis.

9. Considering the aesthetic benefits (and impacts) of infrastructure projects.

Aesthetic aspects of infrastructure options are important to securing public support

It is hard to quantify the benefits of incorporating aesthetic and/or artistic elements into infrastructure projects. We would suggest that infrastructure is on public display, often seen by more people everyday than famous artworks in galleries, and presents a valuable opportunity for artistic expression. It can also be used to create iconic symbols that become recognised landmarks for a city or region. We would encourage IA to think about options for incorporating artistic/aesthetic elements into design. It may not happen if there is no effort to ensure it does.

What are the Impacts of these Problems?

Infrastructure projects come at enormous cost and have long lasting and profound impacts, both positive and negative, on people's quality of life. Whilst the right decisions will build the nation and contribute to our well-being the wrong decisions will be difficult or impossible to undo. CSIRO suggests that Australia needs a more advanced capability to analyse and choose the best infrastructure options in light of sustainability objectives. With today's rapid advancements in technology and major challenges such as climate change, a critical consideration in this analysis is the adaptability of infrastructure choices in response to new opportunities or threats.

Given the Situation What Should be Done First?

We have compiled a list of suggested actions for IA at the beginning of this document under the section labelled "Summary" on page 3.

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